

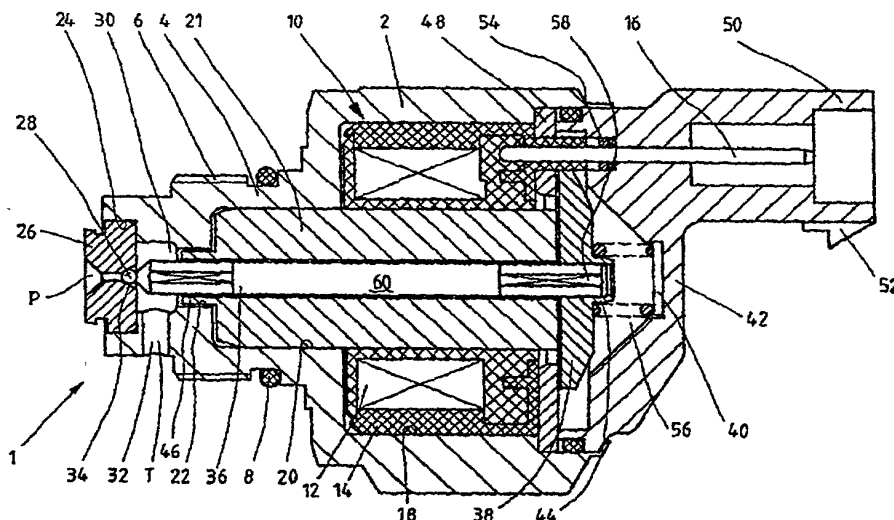
PCT
WELTORGANISATION FÜR GEISTIGES EIGENTUM
Internationales Büro
INTERNATIONALE ANMELDUNG VERÖFFENTLICHT NACH DEM VERTRAG ÜBER DIE
INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT)



<p>(51) Internationale Patentklassifikation ⁶ : F16K 31/06</p>	<p>A1</p>	<p>(11) Internationale Veröffentlichungsnummer: WO 99/66239</p> <p>(43) Internationales Veröffentlichungsdatum: 23. Dezember 1999 (23.12.99)</p>
<p>(21) Internationales Aktenzeichen: PCT/DE99/01577</p> <p>(22) Internationales Anmeldedatum: 28. Mai 1999 (28.05.99)</p> <p>(30) Prioritätsdaten: 198 26 579.4 15. Juni 1998 (15.06.98) DE</p> <p>(71) Anmelder (für alle Bestimmungsstaaten ausser US): MAN- NEMANN REXROTH AG [DE/DE]; Jahnstrasse 3 - 5, D-97816 Lohr (DE).</p> <p>(72) Erfinder; und (75) Erfinder/Anmelder (nur für US): SPAHN, Wolfgang [DE/DE]; Rhönstrasse 34, D-97737 Gemünden (DE). STRAUSS, Klemens [DE/DE]; Lauberweg 32, D-97833 Frammersbach (DE).</p> <p>(74) Anwalt: WINTER, BRANDL; Alois-Steinecker-Strasse 22, D-85354 Freising (DE).</p>		<p>(81) Bestimmungsstaaten: JP, US, europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Veröffentlicht <i>Mit internationalem Recherchenbericht. Vor Ablauf der für Änderungen der Ansprüche zugelassenen Frist; Veröffentlichung wird wiederholt falls Änderungen eintreffen.</i></p>

(54) Title: ELECTROMAGNETIC VALVE

(54) Bezeichnung: MAGNETVENTIL



(57) Abstract

The invention relates to an electromagnetic valve, especially for limiting the pressure of a fluid, comprising a flat armature (38) which is placed in relation to a pole core (21) such that an axial gap is formed. The pole core is inserted into a housing (2) of the electromagnetic valve and subjected to the same fluidic pressure on both faces.

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

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051480-5039

U.S. Application No. 09/719674

International Application. No.

PCT/DE99/01577

International Filing Date

28 May 1999

Priority Date Claimed

15 June 1998

Title of Invention

SOLENOID VALVE

Applicants For DO/EO/US

Wolfgang SPAHN et al.

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

- ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
- ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
- ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
- ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
- ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
- a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
- b. ☒ has been transmitted by the International Bureau.
- c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
- ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
- ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
- a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
- b. ☐ have been transmitted by the International Bureau.
- c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
- d. ☐ have not been made and will not be made.
- ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
- ☐ An oath or declaration of the inventors (35 U.S.C. 371(c)(4)).
- ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

1. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
2. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
3. ☒ A FIRST preliminary amendment.
4. ☐ A SECOND or SUBSEQUENT preliminary amendment.
5. ☐ A substitute specification.
6. ☐ A Verified Statement Claiming Small Entity Status
7. ☐ Other items or information:

7. [X] The following fees are submitted:
- Basic National Fee (37 CFR 1.492(a)(1)-(5)):**
- Search Report has been prepared by the EPO or JPO.....\$860.00
- International preliminary examination fee paid to
 USPTO (37 CFR 1.482).....\$690.00
- No international preliminary examination fee paid to
 USPTO (37 CFR 1.482) but international search fee
 paid to USPTO (37 CFR 1.445(a)(2)).....\$710.00
- Neither international preliminary examination fee
 (37 CFR 1.482) nor international search fee
 (37 CFR 1.445(a)(2)) paid to USPTO.....\$1000.00
- International preliminary examination fee paid to USPTO
 (37 CFR 1.482) and all claims satisfied provisions
 of PCT Article 33(2)-(4).....\$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 860.00

Surcharge of \$130.00 for furnishing the oath or declaration later than

[] 20 [] 30 months from the earliest claimed priority date

(37 CFR 1.492(e)).

Claims	Number Filed	Number Extra	Rate	
Total Claims	14 - 20 =	0	X \$18.00	\$
Independent Claims	1 - 3 =	0	X \$80.00	\$
Multiple dependent claim(s) (if applicable)			+ \$270.00	\$

TOTAL OF ABOVE CALCULATIONS = \$860.00

Reduction by 1/2 for filing by small entity, if applicable. Verified

Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28)

SUBTOTAL = \$860.00

Processing fee of \$130.00 for furnishing the English translation later

an [] 20 [] 30 months from the earliest claimed priority date

(37 CFR 1.492(f)).

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TOTAL NATIONAL FEE = \$860.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The

Assignment must be accompanied by an appropriate cover sheet

(37 CFR 3.28, 3.31).

\$40.00 per property

\$0.00

TOTAL FEES ENCLOSED = \$860.00

Amount to be

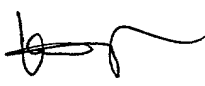
refunded

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charged

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- a. [X] A check in the amount of **\$860.00** to cover the Basic fee is enclosed.
- b. [] Please charge my Deposit Account No. 50-0310 in the amount of **\$860.00** to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. [X] **Except** for issue fees payable under 37 C.F.R. §1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 CFR §1.16 and §1.17 which may be required, or credit any overpayment to Deposit Account No. 50-0310.

 KH01 Q. TA
\$47,300 FOR

END ALL CORRESPONDENCE TO:

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(202) 467-7000

Scott J. Anchell

Reg. No. 35,035

Submitted: December 15, 2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Wolfgang SPAHN et al.)	
)	
Application No.: not yet assigned)	Group Art Unit: not yet assigned
)	
Filed: herewith)	Examiner: not yet assigned
)	
Title: SOLENOID VALVE)	

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to the examination of the above-identified application on the merits, please amend the application as follows:

IN THE CLAIMS:

Please substitute pages 9 and 10 in accordance with 37 C.F.R. § 1.121 ("marked-up" versions identifying the changes are also enclosed).

REMARKS

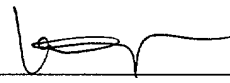
This Preliminary Amendment is being filed in order to eliminate the surcharge for multiple dependent claims. Claims 3, 5, 6, 9-11, and 13 have been amended. New claim 14 has been added in accordance with the amendments to claim 13. Thus, claims 1-14 are submitted for examination.

Applicant respectfully submits that no new matter has been added by this Preliminary Amendment. Entry of the above amendment is respectfully requested.

If there is any fee due in connection with the filing of this Preliminary Amendment, please charge the fees to our Deposit Account No. 50-0310.

Respectfully submitted,
MORGAN, LEWIS & BOCKIUS LLP

Dated: 15 December 2000

By:  *KHOI Q. TA*
Scott J. Anchell
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PAID 300 FOR

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Patent Claims

1. Solenoid valve with winding (12) surrounding a pole core (21) and held in a housing (2) and a spring-stressed flat armature (38), which in its rest position forms an axial air gap with the pole core (21) and which is fastened to a plunger (36) that passes through the pole core (21), on the end section of which that is at a distance from the flat armature a connection can be controlled between a pressure and a drain connection (P, T), characterized in that the pole core (21) is pressure-compensated on both of its faces.
2. Solenoid valve according to claim 1, characterized in that both faces of the pole core (21) are connected to a drain connection (T).
3. Solenoid valve according to claim 1, characterized by a pole disk (48) that surrounds the pole core (1) at a distance and that, with the flat armature (38) delimits a partial area of the air gap lying radially on the outside.
4. Solenoid valve according to claim 1, characterized in that the pole disk (48) is connected to the housing (2) – preferably by crimping or pressing.
5. Solenoid valve according to claim 1, characterized by a valve body (28) that is prestressed against a valve seat (34) by the plunger (36).
6. Solenoid valve according to claim 1, characterized in that the two faces of the pole core(21) are connected to each other by a compensating channel.
7. Solenoid valve according to claim 6, characterized in that the compensating channel is formed between the plunger (36) and an axial hole of pole core (21).
8. Solenoid valve according to claim 6, characterized in that the compensating channel extends along the outer circumference of the pole core (21).

9. Solenoid valve according to claim 5, characterized in that the valve seat (34) is formed of an insert piece (26) that is fastened in housing (2) – preferably by crimping or pressing.
10. Solenoid valve according to claim 1, characterized by a connecting hole (22) that is formed between a holding chamber (20) for the pole core (21) and a chamber (30) of the housing on the drain side, through which the plunger (36) passes with radial play.
11. Solenoid valve according to claim 1, characterized in that the armature chamber (56) is closed by a cover (42) through which coil pins (16) pass, whereby a slot between coil pin (16) and cover passage is sealed by means of a sealing ring.
12. Solenoid valve according to claim 11, characterized in that the coil pins (16) are formed as connector or pin exits.
13. Solenoid valve according to claim 11, characterized in that housing (2) is screwed connected with cover (42), flanged or cast.
14. Solenoid valve according to claim 17, characterized in that housing (2) is screwed connected with cover (42), flanged or cast.

Patent Claims

1. Solenoid valve with winding (12) surrounding a pole core (21) and held in a housing (2) and a spring-stressed flat armature (38), which in its rest position forms an axial air gap with the pole core (21) and which is fastened to a plunger (36) that passes through the pole core (21), on the end section of which that is at a distance from the flat armature a connection can be controlled between a pressure and a drain connection (P, T), characterized in that the pole core (21) is pressure-compensated on both of its faces.
2. Solenoid valve according to claim 1, characterized in that both faces of the pole core (21) are connected to a drain connection (T).
3. Solenoid valve according to claim 1 ~~or 2~~, characterized by a pole disk (48) that surrounds the pole core (1) at a distance and that, with the flat armature (38) delimits a partial area of the air gap lying radially on the outside.
4. Solenoid valve according to claim 1, characterized in that the pole disk (48) is connected to the housing (2) – preferably by crimping or pressing.
5. Solenoid valve according to ~~one of the preceding claims, claim 1~~, characterized by a valve body (28) that is prestressed against a valve seat (34) by the plunger (36).
6. Solenoid valve according to ~~one of the preceding claims, claim 1~~, characterized in that the two faces of the pole core (21) are connected to each other by a compensating channel.
7. Solenoid valve according to claim 6, characterized in that the compensating channel is formed between the plunger (36) and an axial hole of pole core (21).
8. Solenoid valve according to claim 6, characterized in that the compensating channel extends along the outer circumference of the pole core (21).

9. Solenoid valve according to ~~one of claims 5 to 8,~~claim 5, characterized in that the valve seat (34) is formed of an insert piece (26) that is fastened in housing (2) – preferably by crimping or pressing.
10. Solenoid valve according to ~~one of the preceding claims,~~claim 1, characterized by a connecting hole (22) that is formed between a holding chamber (20) for the pole core (21) and a chamber (30) of the housing on the drain side, through which the plunger (36) passes with radial play.
11. Solenoid valve according to ~~one of the preceding claims,~~claim 1, characterized in that the armature chamber (56) is closed by a cover (42) through which coil pins (16) pass, whereby a slot between coil pin (16) and cover passage is sealed by means of a sealing ring.
12. Solenoid valve according to claim 11, characterized in that the coil pins (16) are formed as connector or pin exits.
13. Solenoid valve according to claim 11 ~~or 17~~, characterized in that housing (2) is screwed connected with cover (42), flanged or cast.
14. Solenoid valve according to claim 17, characterized in that housing (2) is screwed connected with cover (42), flanged or cast.

C/PKTS

09/719674
528 Rec'd PCT/PTO 15 DEC 2000

Attorney Docket No. 051480-5039

Description

SOLENOID VALVE

The invention relates to a solenoid valve according to the preamble of patent claim 1.

5 Solenoid valves of this type are used e.g. as pressure-limiting valves in hydraulic circuits or – more recently – in the control of common-rail diesel injection systems. Such valves are characterized by good response, which makes possible a fast pressure reduction in the system, e.g. in the common rail. In design, an effort has been made to structure the valves so that they are as compact as possible, while the flow
10 resistance should be as low as possible.

A previous solenoid valve in flat armature construction is described in DE 43 05 789 A1, in which a coil form is held in an iron core – called the housing in the following. When the coil winding is not under load, the armature forms an axial slot with a pole core. In the known solution, a plunger is fastened to the flat armature, the
15 free end section of which forms a spherical valve body against a valve seat when it is in base position.

When the solenoid valve shown in Figure 1 has power supplied to it, the armature 38 is stressed with a force. This axial force is transferred over the armature 38 to the plunger 36 so that its tip presses the valve body 28 against the valve seat 34 and
20 thus the pressure on the input connection P can be varied.

To decrease the manufacturing technology expense in manufacturing the housing, the pole core and the part of the housing that holds the coil form can be designed as two parts – as suggested in DE-OS 31 26 246. In designs such as this, the pole core stressed on its face that is at a distance from the flat armature with the fluid
25 pressure acting on the valve body, so that a resulting pressure force acting in axial direction acts on the pole core. Since the pole core is often mounted by being pressed into the housing, under unfavorable conditions, i.e. with high input pressure and insufficient contact pressure between pole core and housing, it is possible for the pole core to be slid in axial direction toward the flat armature. Because of this change in the

air gap, the magnetic force acting on the flat armature can no longer be unambiguously correlated to the opening cross section of the valve seat. This can lead to the fact that the valve response no longer corresponds to the specifications so that recalibration of the solenoid valve is necessary.

5 In contrast to this, the invention is based on the task of producing a solenoid valve in which functional safety is improved with minimum equipment technology expense.

The task is solved by the characteristics of patent claim 1.

Because of the measure according to the invention of stressing the pole core,
10 which is separate from the housing, axially with about the same pressure, even a high input pressure can not lead to the pole core becoming displaced and the air gap thereby becoming changed. In this way, taking special measurements for axial determination in the housing can be avoided so assembly can be carried out in the previously customary manner, e.g. by pressing or crimping.

15 Since the input connection is frequently connected to a drain or tank connection by way of the pressure limiting valve, it is especially advantageous if this low system pressure (tank pressure) is applied to both faces of the pole core.

In a preferred variation, the housing is provided with a ring-shaped pole disk, whose side turned toward the armature matches the adjacent face of the pole core so
20 that the axial air gap is limited on side by the armature and on the other side by the pole core and the pole disk.

It is especially simple to manufacture the solenoid valve according to the invention if the pole disk is crimped with the housing.

Usually a plunger is fastened on the flat armature, this plunger acting on the
25 valve body with its free end section and pressing it against the valve seat in basic position (minimum air gap). In this process, the plunger passes through the pole core along its axial direction. In a first alternative, a compensating channel can be formed to produce the pressure compensation between the two pole core faces, in that the plunger cross section is designed with a smaller dimension or with flattened areas, etc. so that a
30 compensating channel is formed between the axial hole of the pole core and the plunger. Alternatively to this, a corresponding channel can be formed on the outer

circumference of the pole core so that this compensation channel is delimited by the housing and the outer circumference of the pole core. In both variations, it is insured that the face on the valve seat side and the face on the armature chamber side of the pole core can be stressed with the same pressure with minimum manufacturing
5 technology effort.

This effort can be further reduced if the valve seat is formed on an insert piece that is installed in the housing. In this process, the connection is preferably made by crimping.

In this design, the chamber of the housing formed upstream of the insert piece is
10 connected to the holding chamber for the pole core by way of a connecting hole. In this, the connecting hole is designed so that it is larger than the corresponding outer diameter of the plunger passing through it so that the ring chamber between plunger and connecting hole is part of the compensating channel for stressing the two pole core faces with pressure.

15 The armature chamber of the housing is preferably closed with a cover that has coil pins passing through it, while sealing rings are provided for the coil pins in the feed-through hole.

The structure of the valve is especially simple if this cover is designed as a connector or pin exit.

20 In this process, it is especially preferred if the housing is chamfered along some of its circumference for fastening the cover.

Other advantageous further developments of the invention are the object of the other subclaims.

In the following, preferred embodiments of the invention will be explained in
25 more detail using schematic drawings. They show:

Figure 1 is a longitudinal cross section through a first embodiment of a solenoid according to the invention;

Figure 2 is a side view of the solenoid valve from Figure 1 and

Figure 3 is a second embodiment of a solenoid valve according to the invention.

30 Figure 1 shows a longitudinal cross section through a solenoid valve that is designed as a pressure limiting valve for common-rail diesel injection systems. A

pressure connection P is connected by way of this solenoid valve 1 to a drain connection, preferably a tank connection T when the system pressure at connection P reaches a specified limit value. It is especially important, in particular in common-rail systems in which the injection pressure must not exceed a predetermined value, if excess pressure can be reduced as quickly as possible. Another criterion is that the pressure limiting valve has a structure that is as compact as possible with low part weight so that a light-weight design with higher reliability can be made available. These requirements are fulfilled in an exemplary manner by the solenoid valve according to the invention.

This solenoid valve has a housing 2 manufactured of a magnetic metal, which is designed in cartridge construction and can be screwed into a valve block – or in the present case, into the housing of the rail high pressure pump. For this purpose, an outer thread 6 is formed on a radially recessed insert collar 4, with which a sealing ring 8 is associated for sealing with the rail or the high pressure pump

A coil form 10 is held in the radially expanded area of housing 2. This has a winding 12 that is embedded in plastic shroud 14.

Power is supplied to winding 12 by way of pins 16 that extend axially out of housing 2.

In the embodiment shown, housing 2 is designed as a barrel in the view according to Figure 1, seen from the right, and surrounds a coil chamber 18 for holding the coil form 10 and a holding chamber 20 for a pole core 21, recessed radially compared to coil chamber 18, which in the embodiment is manufactured of the same material as the housing. This holding chamber extends out of coil chamber 18 into the insert collar 4.

A connecting hole 22 that expands in stages to a holder 24 for an insert piece 26, on which a tapered valve seat 34 is formed on input connection P, is connected to the holding chamber 20.

A chamber 30 is formed between the insert piece 26 and the mouth of the connecting hole 22, in which the tank connection T opens out as radial hole 32 (or radial hole star).

In the basic position shown in Figure 1, the connection between tank connection T and input connection P is closed by means of spherical valve body 28 that is prestressed against valve seat 34 by a plunger 36. The contact area of plunger 36 to valve body 28 is reduced conically.

5 On the end section of the plunger 36 furthest from valve seat 34, a flat armature 38 is mounted on which a compression spring 40 engages that is supported on a plastic cover of housing 2. In the embodiment shown, the right end section of plunger 36 passes through the flat armature 38. In this process, the plunger is designed with a press fit with respect to the center hole of flat armature 38 and additionally chamfered with it
10 by way of chamfer 44 so that an axial displacement of flat armature 38 along plunger 36 during normal operating conditions is almost ruled out. The chamfering 44 forms a hub-shaped section that is surrounded by compression spring 40 and secures it in radial direction.

Pole core 21 is inserted into holding chamber 20 of the housing with press fit
15 and, in the embodiment shown, dips with a hub-shaped projection into connecting hole 22. However, the outer diameter of the hub-shaped projection is smaller than the selected hole diameter so that a ring slot is formed through which fluid, in this case, diesel fuel, can pass through from chamber 30.

The other face of pole core 21 extends through the coil form 10 up to flat
20 armature 38. The relative arrangement is selected in such a way that in the base position shown, i.e. when valve body 28 is contacting valve seat 34, an axial air slot is formed between the right face (view according to Figure 1) of the pole core 21 and the adjacent large surface of armature 38.

Between the part of coil form 10 surrounding winding 12 and the flat armature
25 38, a pole disk 48 is mounted in a radial shoulder of housing 2. The connection between housing 2 and this pole disk 48 can occur, for example, because of an axial crimp, so this connection can be produced in an extremely simple manner.

Pole disk 48 overlaps flat armature 38 in radial direction. The large surface
30 pointing toward the latter lies in the face plane of pole core 21 so that the pole piece surrounds the end section of pole core 20 projecting out of coil form 10 in a ring shape,

at a distance. As a result, in some sections, the air gap is also delimited by pole piece 48 and flat armature 38.

As can be seen from the upper part of Figure 1, the pins 16 and a part of the plastic shroud 14 of coil body 10 surrounding it pass through a recess in pole piece 48.

5 Pins 16 also pass through cover 42 of housing 2, whereby in the embodiment shown, in the passage area of the pins 16, a connection housing 50 surrounding them is formed, which together with pins 16 forms a connector exit. Connector housing 50 has a locking projection 52 to connect to the opposite piece of the plug connector.

10 The pass-through hole for each pin 16 through cover 42 and the connector housing 50 formed with it is expanded on the coil-side end section to hold an O-ring gasket 54 so that there is a seal with the armature chamber 56 delimited by cover 42.

In order to prevent displacement of pole core 21 when there is excessive pressure in chamber 30, armature chamber 46 is connected to chamber 30 by way of a connecting channel so that both faces of the pole core 21 will be stressed with
15 essentially the same pressure.

Several options exist for forming this connecting channel. In the embodiment shown in figure 1, the plunger is provided with flattened surfaces 58 so that the pressure fluid (diesel fuel) can escape out of chamber 30 and/or out of armature chamber 46 along the flattened surfaces 58 into the throughput hole of pole core 21.

20 Since these flattened places 58 have to be produced with relatively great effort, the center area 60 of plunger 36 is designed with a smaller diameter than the two end sections provided with flattened areas 58 so that a ring slot is formed between center area 60 and the peripheral wall of the pass-through hole for pole core 21, which makes passage of the fluid possible.

25 Alternatively, the flattened areas 58 could naturally also be designed to be interconnected.

In a variation that is not shown, a spiral-shaped or axial peripheral groove can be formed on the outer circumference so that the fluid can go from chamber 30 through the connecting hole 22 and along the left face of pole core 21 into this peripheral recess
30 and from there, along the outer circumference of pole core 21 to armature chamber 45 so that in this way, the same pressure is also present in chambers 56 and 30.

As a modification from the embodiment shown in Figure 1, the projection of pole core 21 that dips into connecting hole 22 can be eliminated so its left face is designed so that it is flat. What is important is that the fluid can pass through the connecting hole.

5 When the power supply is interrupted, the flat armature 38 will be moved back to its initial position because of the force of compression spring 40, whereby plunger 36 presses valve body 34 [sic] against valve seat 34 so that the end position of magnetic armature 38 with respect to pole core 21 is determined by the contact of valve body 28 on valve seat 34. The material pairs must therefore be selected in such a way that wear
10 in the area of the valve body 28 contact against plunger 36 and against valve seat 34 is restricted to a minimum so that the width of the air gap remains within the specified tolerances.

As can be seen from the representation according to Figure 2, tabs 62 are formed that are distributed on the outer circumference of housing 2, these tabs being
15 flattened down after the cover 42 seats so that they are fastened to the housing.

Figure 3 shows an embodiment in which cover 42 is designed as a pin exit and thus has no connector housing 50, but only has pins 16 passing through it. In addition, the structure of the embodiment shown in Figure 3 corresponds to that of the embodiment shown in Figure 1 so that further designs can be avoided.

20 The solenoid valve can be designed with valve seat, as well as with a sliding seat, while in the latter case the plunger runs against a stop that defines a switching position.

The design according to the invention can basically also be used in valves that are open in rest position and then are closed when power is applied to the winding.

25 The solenoid valve shown is distinguished by an especially simple and compact structure, whereby assembly can be carried out with comparatively little effort. In the assembly, special attention should be given to the correct structure of the air gap and the matching arrangement of pole disk 48 and pole core 21. In a patent application submitted in parallel by the applicant, the corresponding calibration process is
30 described in detail so that reference is made to the elaborations in parallel patent application P... with internal file number MA7256.

A solenoid valve is disclosed, in particular for limiting the pressure of a fluid, with a flat armature that is mounted with an axial gap from a pole core. This pole core is used in a housing of the solenoid valve and will be stressed with the same fluid pressure from both faces.

Patent Claims

1. Solenoid valve with winding (12) surrounding a pole core (21) and held in a housing (2) and a spring-stressed flat armature (38), which in its rest position forms an axial air gap with the pole core (21) and which is fastened to a plunger (36) that passes through the pole core (21), on the end section of which that is at a distance from the flat armature a connection can be controlled between a pressure and a drain connection (P, T), characterized in that the pole core (21) is pressure-compensated on both of its faces.
2. Solenoid valve according to claim 1, characterized in that both faces of the pole core (21) are connected to a drain connection (T).
3. Solenoid valve according to claim 1 or 2, characterized by a pole disk (48) that surrounds the pole core (1) at a distance and that, with the flat armature (38) delimits a partial area of the air gap lying radially on the outside.
4. Solenoid valve according to claim 1, characterized in that the pole disk (48) is connected to the housing (2) – preferably by crimping or pressing.
5. Solenoid valve according to one of the preceding claims, characterized by a valve body (28) that is prestressed against a valve seat (34) by the plunger (36).
6. Solenoid valve according to one of the preceding claims, characterized in that the two faces of the pole core(21) are connected to each other by a compensating channel.
7. Solenoid valve according to claim 6, characterized in that the compensating channel is formed between the plunger (36) and an axial hole of pole core (21).
8. Solenoid valve according to claim 6, characterized in that the compensating channel extends along the outer circumference of the pole core (21).

9. Solenoid valve according to one of claims 5 to 8, characterized in that the valve seat (34) is formed of an insert piece (26) that is fastened in housing (2) – preferably by crimping or pressing.

10. Solenoid valve according to one of the preceding claims, characterized by a connecting hole (22) that is formed between a holding chamber (20) for the pole core (21) and a chamber (30) of the housing on the drain side, through which the plunger (36) passes with radial play.

11. Solenoid valve according to one of the preceding claims, characterized in that the armature chamber (56) is closed by a cover (42) through which coil pins (16) pass, whereby a slot between coil pin (16) and cover passage is sealed by means of a sealing ring.

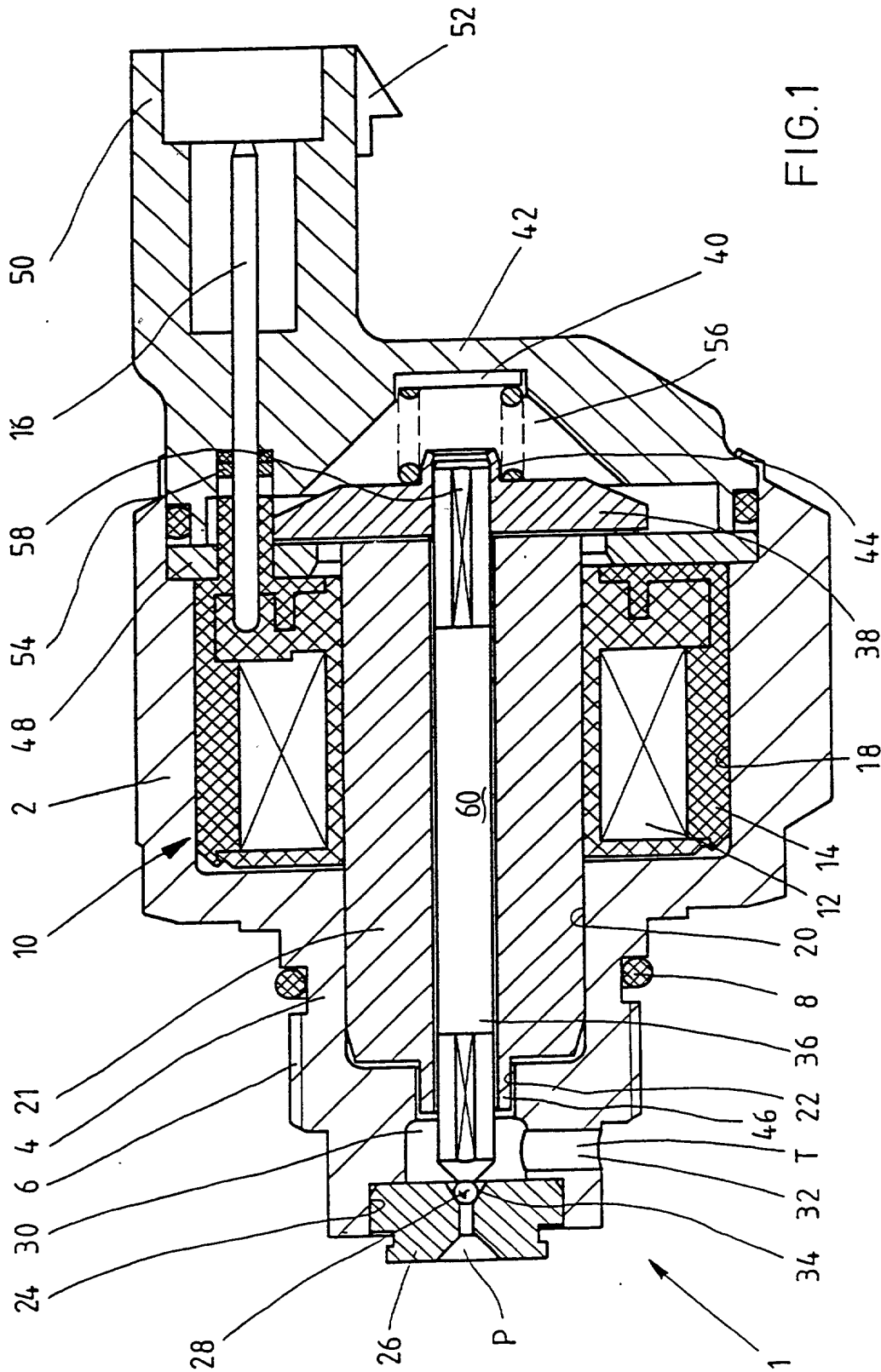
12. Solenoid valve according to claim 11, characterized in that the coil pins (16) are formed as connector or pin exits.

13. Solenoid valve according to claim 11 or 17, characterized in that housing (2) is screwed connected with cover (42), flanged or cast.

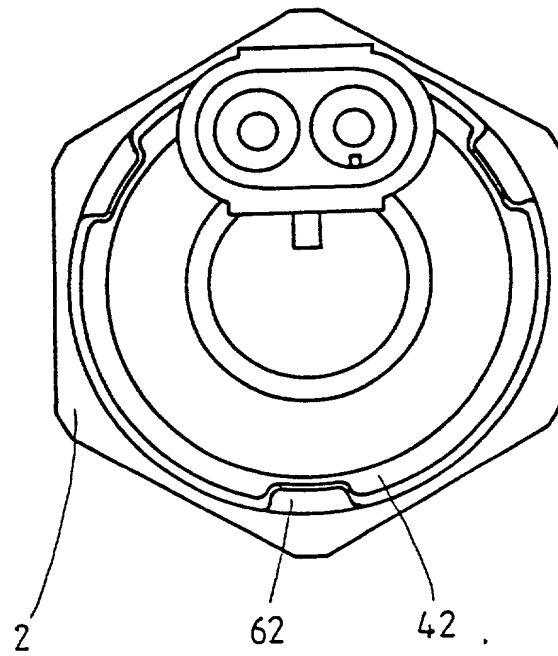
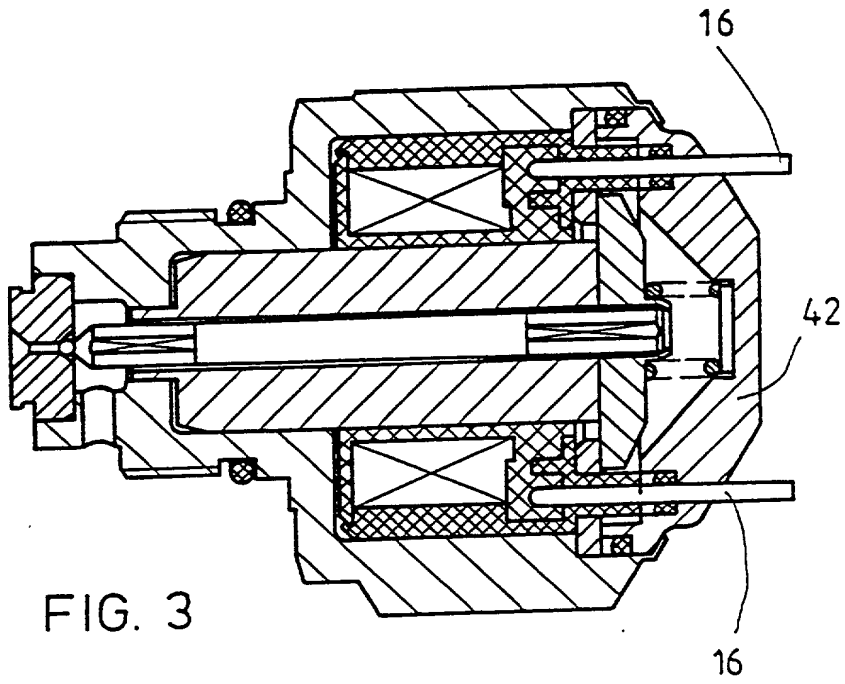
Summary

A solenoid valve is disclosed, in particular for limiting the pressure of a fluid, with a flat armature that is mounted with an axial gap to a pole core. This pole core is
5 installed in a housing of the solenoid valve and is stressed from both faces with the same fluid pressure.

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2/2



Declaration and Power of Attorney for Patent Application

Erklärung für Patentanmeldungen mit Vollmacht

German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

daß mein Wohnsitz, meine Postanschrift und meine Staatsangehörigkeit den im nachstehenden nach meinem Namen aufgeführten Angaben entsprechen, daß ich nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent für die Erfindung mit folgendem Titel beantragt wird:

MAGNETVENTIL

deren Beschreibung hier beigelegt ist, es sei denn (in diesem Falle Zutreffendes bitte ankreuzen), diese Erfindung

- ☒ wurde angemeldet am 15 Dezember 2000 unter der US-Anmeldenummer oder unter der Internationalen Anmeldenummer im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT) 09/719,674 und am abgeändert (falls zutreffend).

Ich bestätige hiermit, daß ich den Inhalt der oben angegebenen Patentanmeldung, einschließlich der Ansprüche, die eventuell durch einen oben erwähnten Zusatzantrag abgeändert wurde, durchgesehen und verstanden habe.

Ich erkenne meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Titel 37, Code of Federal Regulations, § 1.56 von Belang sind.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SOLENOID VALVE

the specification of which is attached hereto unless the following box is checked:

- ☒ was filed on 15 December 2000 as United States Application Number or PCT International Application Number 09/719,674 and was amended on (if Applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office information which is material to the patentability of claims presented in this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäß Title 35, US-Code, § 119 (a)-(d), bzw. § 365(b) aller unten aufgeführten Auslandsanmeldungen für Patente oder Erfinderurkunden, oder § 365(a) aller PCT internationalen Anmeldungen, welche wenigstens ein Land ausser den Vereinigten Staaten von Amerika benennen, und habe nachstehend durch ankreuzen sämtliche Auslandsanmeldungen für Patente bzw. Erfinderurkunden oder PCT internationale Anmeldungen angegeben, deren Anmeldetag dem der Anmeldung, für welche Priorität beansprucht wird, vorangeht.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate or §365(a) of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

Prior Foreign Applications
(Frühere ausländische Anmeldungen)

(Number)
(Nummer)

(Country)
(Land)

(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

☐ Priority Not Claimed
Priorität nicht beansprucht

(Number)
(Nummer)

(Country)
(Land)

(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

☐ Priority Not Claimed
Priorität nicht beansprucht

(Number)
(Nummer)

(Country)
(Land)

(Day/Month/Year Filed)
(Tag/Monat/Jahr der Anmeldung)

☐ Priority Not Claimed
Priorität nicht beansprucht

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

I hereby claim the benefits under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

Provisional Applications
(Hilfsanmeldungen)

(Application No.)
(Aktenzeichen)

(Filing Date)
(Anmeldetag)

(Application No.)
(Aktenzeichen)

(Filing Date)
(Anmeldetag)

(Application No.)
(Aktenzeichen)

(Filing Date)
(Anmeldetag)

Ich beanspruche hiermit die mir unter Title 35, US-Code, § 120 zustehenden Vorteile aller unten aufgeführten US-Patentanmeldungen bzw. § 365(c) aller PCT internationalen Anmeldungen, welche die Vereinigten Staaten von Amerika benennen, und erkenne, insofern der Gegenstand eines jeden

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or § 365(c) of any PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this

früheren Anspruchs dieser Patentanmeldung nicht in einer US-Patentanmeldung, bzw. PCT internationalen Anmeldung in einer gemäß dem ersten Absatz von Title 35, US-Code, § 112 vorgeschriebenen Art und Weise offenbart wurde, meine Pflicht zur Offenbarung jeglicher Informationen an, die zur Prüfung der Patentfähigkeit in Einklang mit Title 37, Code of Federal Regulations, § 1.56 von Belang sind und die im Zeitraum zwischen dem Anmeldetag der früheren Patentanmeldung und dem nationalen oder im Rahmen des Vertrags über die Zusammenarbeit auf dem Gebiet des Patentwesens (PCT) gültigen internationalen Anmeldetags bekannt geworden sind.

application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to the patentability of claims presented in this application in accordance with Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application.

Prior U.S. Applications and PCT International Applications Designating the U.S.
(US-Patentanmeldungen und PCT internationalen Anmeldungen, welche die US benennen)

PCT/DE99/01577	28/05/1999	Pending
(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)	(Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)
(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)	(Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)
(Application No.) (Aktenzeichen)	(Filing Date) (Anmeldetag)	(Status) (patented, pending, abandoned) (Status) (patentiert, schwebend, aufgegeben)

VERTRETUNGSVOLMACHT: Als benannter Erfinder beauftrage ich hiermit eingeschrieben Praktiker Morgan, Lewis & Bockius LLP eingeschlossen ein Kunde Nummer beliefert unten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Angelegenheiten vor dem US-Patent und Markenamt. Gesamt korrespondenz sollte sein adressiert zur das Kunde Nummer.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the registered practitioners of Morgan, Lewis & Bockius LLP included in the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith. All correspondence should be addressed to that Customer Number.

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Postanschrift:

Send Correspondence to:

David W. Laub

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Direct Telephone Calls to: (name and telephone number)

David W. Laub (215-963-5355)

Ich erkläre hiermit, daß alle in der vorliegenden Erklärung von mir gemachten Angaben nach bestem Wissen und Gewissen der Wahrheit entsprechen, und ferner daß ich diese eidesstattliche Erklärung in Kenntnis dessen ablege, daß wissentlich und vorsätzlich falsche Angaben oder dergleichen gemäß § 1001, Title 18 des US-Code strafbar sind und mit Geldstrafe und/oder Gefängnis bestraft werden können und daß derartige wissentlich und vorsätzlich falsche Angaben die Rechtswirksamkeit der vorliegenden Patentanmeldung oder eines aufgrund deren erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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Unterschrift des dritten Erfinders:	Datum:	Third inventor's signature:	Date:
Wohnsitz:		Residence:	
Staatsangehörigkeit:		Citizenship:	
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(Im Falle vierter und weiterer Miterfinder sind die entsprechenden Informationen und Unterschriften hinzuzufügen.)

(Supply similar information and signature for fourth and subsequent joint inventors.)